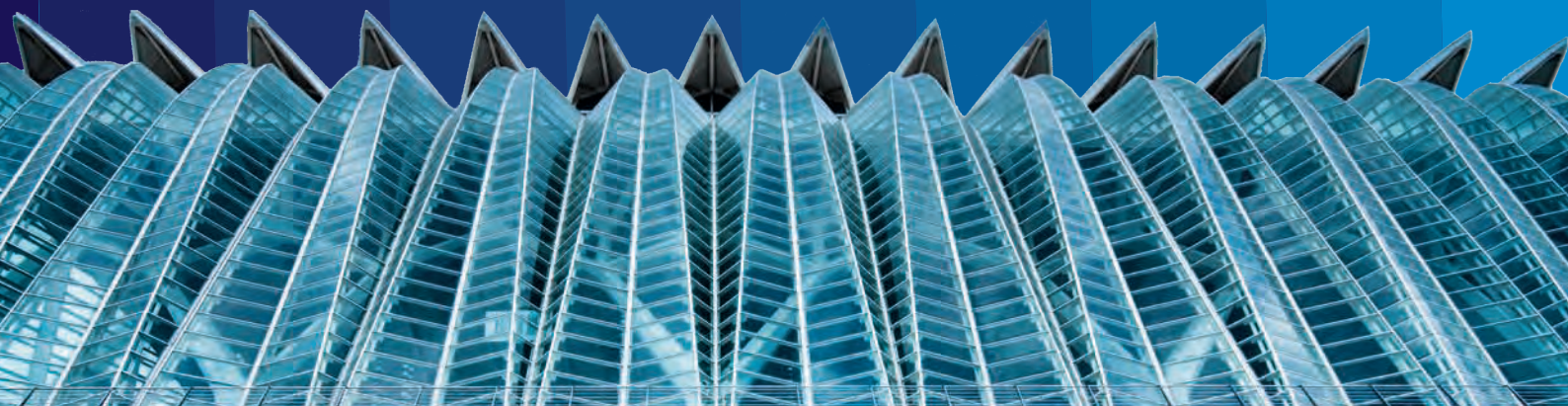


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CASE-BASED LEARNING IN MATERIALS ENGINEERING: THE OUIJA BOARD OF THE DEVIL

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Abstract

Students' training on electrical mechanical engineering is based on the acquisition of disciplinary knowledge in the following areas: thermodynamics, quality control, safety and hygiene, materials and mechanical, electrical and electronic design. To apply the application of this knowledge to the solution of real problems, requires higher-order cognitive skills such as the development of complex thinking, among others. Case-based Learning (CBL) is a methodology that favors active learning and the construction of arguments, allowing students to see theory in the practice of a real-life context. In materials engineering, the characterization techniques allow to evaluate the properties of the materials, and therefore determine if it is useful for a given application. Traditionally, students learn this content from following procedures. But deciding which technique to use causes those difficulties, especially when it is necessary to define the variables to be measured. During a Materials Engineering class, a case-based educational strategy was applied to a group of 19 Electrical Mechanical Engineering students, at the public University of San Luis Potosí, Mexico, with the purpose of evaluating the knowledge acquired in the subject. The solution of the case *"The Ouija of the Devil: the Molecular detector GT200"*, allowed them to identify the level of knowledge on characterization techniques, the variables involved, the limitations, and necessary parameters to carry out the measurements. On the other side, the importance of scientific knowledge was identified to solve problems, as well as its impact on decision-making in public policies and resource management. This case is also associated to the acquisition of fake, useless equipment by the Mexican government. It allowed exploring the student's opinions towards corruption and the necessary values to practice the profession. The proposed methodology was that of CBL. The learning evidence was analyzed under a qualitative approach.

Keywords: Case-Based Learning, materials engineering, CTS, electrical mechanic engineering.

1 INTRODUCTION

University education trains students not only in the acquisition of scientific knowledge and technical skills, but also in the development of a scientific train of thoughts that contributes to making decisions based on the knowledge acquired. It is important to emphasize to the students, that upon leaving the university they will be part of Society, and that at a certain moment they will attend to the solution of diverse problems, considering also the several ethical aspects of their career. In Mexico, there are strong corruption issues, not only in government but in all environments, including academia. This has led to a values crisis that has emphasized, among many other problems, extreme poverty and violence, even in the most remote places of the country.

Active learning is required to facilitate student's learning. Bringing real situations to the classroom that evidence the values crisis in Mexico and the effects of corruption, as well as the importance of scientific knowledge to identify frauds, is urgent if we want to have a better future.

During the training of engineers, students acquire disciplinary knowledge in different areas. In the Mechanical Electric Engineering career, their training focuses on the following areas: mechanics, electrical, computer-aided design, thermal, quality and safety and a solid training in the area of materials. During their third semester, they study the material engineering subject.

Within the Engineering Materials class, the academic content of "characterization of materials" is included. In this subject, the students review the techniques that allow them to learn the elements present in a material, whether metal, polymer, ceramic, or composite. Mechanical tests are also studied to identify the mechanical properties of the materials. The objective of the course is that the student obtains the ability to select the material for a given application, due to its properties. Knowing the characterization techniques and their scope, is then a relevant content for their training.

In order to make students aware of the relationship that exists in the usefulness of material characterization techniques in the solution of real problems, a didactic strategy was designed based on the case-based learning methodology using the case *"The Ouija of the Devil: the Molecular detector GT200"*. In addition to reflecting on the usefulness of science, the effects of corruption in the society. The lack of knowledge about a subject impacts in the decision making of the same.

2 BACKGROUND

Case-based learning as a didactic strategy, seeks to analyze problematic situations that occurred in a real context. The case is written describing the facts of the problem, so when analyzing the case, the students relive about them looking for a solution to the problem, identifying the causes that originated the problem and its consequences in the context where the problem has occurred. Figure 1 describes the steps in which the methodology should be carried out [1].

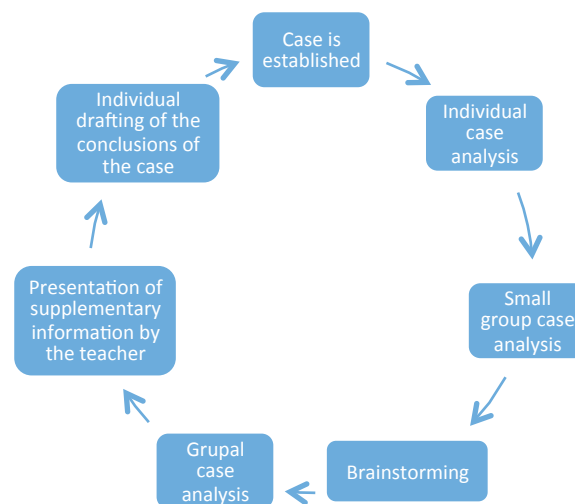


Figure 1. CBL process.

The purpose of using CBL is to construe the development of higher order cognitive skills, as well as critical and scientific thinking through the analysis of a real situation, and the elaboration of arguments based on disciplinary knowledge. Likewise, it is emphasized that the learning provided by the presentation of the case, makes it possible to transfer the knowledge, skills, attitudes of the solution of a situation, case and / or problem to a new experience [2], which has similar characteristics. It was reported that students' reasoning, interpretations, and the ability to think logically was improved with CBL [3] [4] [5]. During the teaching of engineering students, CBL has been successful. As reported by Torres (2010) courses become more interactive; since the teacher-student relationship modifies the appreciation of knowledge [6].

In this work we considerate very important the Science, Technology and Society (CTS) approach, because this aspires that the scientific culture contributes to motivate students in the search for information allusive to science, and technology in relation to the problems that afflict their social context. To reflect, analyze and evaluate situations, and thus propose solutions by participating actively in the decision making of the community [7].

3 METHODOLOGY

Using the case-based learning methodology, we will analyze "The Ouija of the Devil: the Molecular detector GT200" case, which was designed based on a newspaper article from the "El País" newspaper [8], which reports the purchase of dozens of GT 200 molecular detectors (Fig. 2), by the Mexican government, with a cost over 400 million pesos. It was able to detect, from a distance, various different substances including explosives, drugs, and even people and money hidden in a vehicle on movement. The GT200 consists of three main components—a swiveling antenna mounted via a hinge to a plastic handgrip, into which "sensor cards" can be inserted. The apparatus was used by the Mexican army and other policy department and it supposed to work without any mechanism or electronic device, even doesn't need batteries or electrical input, because it used the static electricity of the human body [9].



Figure 2. GT 200 apparatus. Source: <http://www.abc.es/Media/201110/18/MEXICO--644x362.jpg>

The case has been designed for application applied to a group of 19 second-year students of the Mechanical Electric Engineering career, aged between 19 and 22 years, for their analysis and resolution groups were formed cooperatives (of three or four students). It was done in 2 sessions of two hours.

The process of analysis and resolution of the case relates the contents associated to the techniques of characterization of materials, to know the properties of the materials and the physical principles that make the identification possible, as well as the difficulties in the measurement of the variables. It includes aspects that lead the student to justify if the GT200 can work under the principles that the manufacturer assures or not, arguing scientifically the proposal. It also wishes to reflect on the social implications of corruption by the Mexican Government. Initially, the student was given the case to read at home and was asked to prepare a document considering the following four phases:

- Phase I. Enumeration of facts:
Description of the situation presented in the case according to the student's perspective
- Phase II. Identification and presentation of alternatives
The characteristics that the GT 200 presents
List of characterization techniques that allow the identification of molecular species
- Phase III. Valuation, comparison and presentation of solution alternatives
Relationship between the characteristics of the GT200 with the characterization techniques
- Phase IV. Selection of the best alternative
Preparation of conclusions resulting from the previous comparison

The student should have a copy of the work with them for their use in the next session. The activities performed in sessions 1 and 2 are described in table 1.

Table 1. Description of activities carried out during the solution of the case.

Session	Description of activities
One	<p>The teacher recovered the material made by the students as evidence of having done the activity</p> <p>Later I request the students to form groups of 3 students, make comparisons between their writings</p> <p>After a 15-minute discussion, they were asked to compile a list of coincident and disagreeing points</p> <p>Later they were asked to carry out the activities but now with the perspective of the three students.</p> <p>For a time of 15 minutes</p> <p>A representative of each team was selected to present their solution on the board</p> <p>A discussion of the different proposals was carried out until obtaining coincident and discrepant points but now of the whole group</p> <p>The teacher served as moderator of the session, asking questions to guide the students during the discussion both in small groups and in the group discussion</p>
Two	<p>Individually the students completed the activities of the format shown in figure 1</p> <p>A discussion was held about the possible causes of the problem and how these situations could be avoided in the future</p> <p>There was also a group reflection on how scientific knowledge influences the identification of possible frauds</p> <p>Finally, a group reflection was made about the effects of an act of corruption or lack of scientific culture on specific members of society</p> <p>Each student elaborated a personal discussion of the previous points</p>

4 RESULTS AND DISCUSSIONS

In the Engineering field, students are required to recall a lot of knowledge and skills learned during their time at the University, and also to keep updating that knowledge with the latest research and technology, especially because technology changes by leaps and bounds. Active learning methodologies contributes to make teaching more effective, and to enhance learning and retention, as well to inculcate self-directed learning skills in Mechanical Engineering students.

At the beginning of the study, students thought the case was false because they argue it's not possible to buy an apparatus with this characteristics. One student said "It is obvious this GT 200 doesn't work like they said, it is very simple".

We analyzed the individual solution of the case, and we found most of the students used the book definition to answer the first question. Related to question 3, students argued about the social effects of using an apparatus that does not give true results, as these false results will result in the wrong data such as the presence of prohibited products in vehicles of some people, and then the wrongful imprisonment of them, affecting strongly their economy and personal life. They reflected on how some decisions impact other people's lives. In their totality, they assumed that the purchase, rather than a problem of scientific culture, was a problem of corruption.

In the group discussion, students argued that the measurements made in the laboratory are made under strict control. Considering the measurement errors, the technology that is in these devices, compared with the explanation of a simple operation given by the sellers, was totally false.

In terms of knowledge on how to identify each of the objects sought (drugs, money, weapons, etc.), students searched in the class' books of the course to be able to respond. Approximately half of the students recognized that they had no idea how to identify these materials.

During the group discussion, students proposed that when the Purchasing Department of a Security Agency hires disciplinary experts to make an evaluation of a technology that seems to be innovative or that offers almost immediate solutions, the procurement bids were always open so that the population could know what is done with public resources.

5 CONCLUSIONS

Case Base Learning contributes to the Engineering student's retention, and they were better able to ask questions and make comments during class. CBL made the learning more enjoyable. The

students were really worried about how the people that take important decisions in the Government doesn't take in account the impact to others' life. A topic of difficult understanding, such as the characterization of materials for engineering use, was better understood by the students when immersed in a real story with implications in the lives of other people, which reinforces the values of responsibility and ethics in the exercise of the profession.

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APPENDIX I

THE CASE GT200: THE OUIJA OF THE DEVIL

Analysis of the case

1. Define technique for characterization of materials?
 - a. What are the techniques of characterization of materials that can be used to identify
 - b. the chemical composition of a material the presence of people inside a bus
 - c. the presence of people in the dark
 - d. the existence of banknotes in a suitcase
 - e. Explosives in a vehicle
2. In the case of the GT200, the molecular marker unit describe what the effects of the acquisition of such equipment are.
3. Make a list of 5 points of interest of the note Determine because this article has scientific importance
4. Complete the following table

Identify the presence of:	Characteristics of the technique for characterization of materials	Characteristics del GT200	Comparative
People			
Explosives			
Money			
Cocaine			
Marijuana			
Methamphetamine			
Weaponry			

5. Explain what are the parameters in which the person who was dedicated to the purchase of the complete apparatus.
6. In its conclusions of the problem and propose a measure so that this problem does not occur again in our country.
7. Explain how it helps people's scientific knowledge to address this problem.